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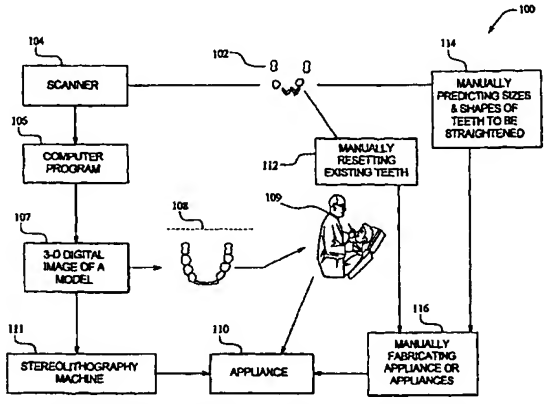

(57) Abstract: An orthodontic appliance (110,400), a system (100) and a method are provided for automatic tooth straightening. The appliance (110,400) may be fabricated manually or by stereolithography using a computer program (106) that formulates a three-dimensional digital model (107). The appliance (110,400) or series of appliances (110,400) may be made to fit a particular patient wherein a portion of the appliance (110,400) may be attached to fully erupted teeth (306) that are substantially straight. The appliance (110,400) may fit onto the teeth (306) that do not require straightening using a section (402) made from a relatively stiff material so that the appliance (110,400) remains in the mouth in a relative constant position. The erupted teeth (302) that require straightening may be straightened with an area (404) of the appliance (110,400) formed of a softer, more resilient material so that fewer appliances may be required than if a stiffer material were used. The unerrupted teeth (304) may be guided into the mouth by another portion (406) of the appliance (110,400) that is performed with predicted sizes and shapes of teeth determined from anatomical standards. The appliance (110,400) may be formed of a hard stiffer inner shell (502) overlaid by a soft outer layer (501).

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ORTHODONTIC APPLIANCE BASED ON PREDICTED SIZES AND SHAPES OF UNERRUPTED TEETH SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

The present invention generally relates to an apparatus, a system and a method for straightening of teeth. More specifically, the present invention relates to an orthodontic appliance that may be placed on teeth to straighten teeth and a method for using the same.

It is, of course, generally known to provide an apparatus for straightening teeth. Throughout the life of an individual, teeth often require corrective measures to remain healthy or to correct defects with which an individual may be born or develop at later ages, such as an overbite, overjet, crowding, rotations, and/or spacing of teeth. The need for corrective measures for teeth has brought about various procedures, examinations, diagnoses and the like, such as those provided by a dentist or orthodontist, as well as corrective measures in the form of dental appliances which may be worn in the mouth.

However, orthodontists often are inaccessible due to a person's schedule, geographic location or various other reasons. Moreover, such professionals may be unaffordable to some individuals.

Generally, orthodontics is provided during the developmental years of a patient because significant facial growth takes place during this period. Further, during the developmental years, there is typically additional space in the mouth of the patient for easier

correction of crowding teeth and for easier straightening of erupting teeth due to the large deciduous molars and relatively smaller permanent premolars that replace them.

It is generally known to provide an appliance made of a material with an elevated durometer or stiffness which is made directly from the exact anatomy of the teeth of a patient. This type of appliance is usually vacuum or pressure formed, often by a machine called "Biostar." (Sold by Dentaurum) The appliance is generally snapped into place into various undercuts. However, it is often difficult to move teeth to their proper position because of the stiffness and relative lack of resiliency of the appliance.

A need, therefore, exists for an improved apparatus and method for providing automatic tooth straightening that may be snapped into place on some teeth that will not need straightening or that will remain in the mouth in a relative constant position without the need for frequent replacement. A need further exists for an improved appliance having a semi-stiff or soft customized part based on the actual anatomy of the teeth of the patient or prefabricated portion based on predicted sizes and shapes of teeth derived from means of groups of teeth for providing tooth straightening for teeth that are erupting. Additionally, a need exists for an improved appliance for the guidance of unerupted teeth into the mouth or for easier and faster straightening of already erupted, crowded, rotated or spaced teeth.

SUMMARY OF THE INVENTION

The present invention generally relates to an appliance or apparatus, a system and a method for automatic tooth straightening. More specifically, the present invention provides a customized appliance that may be placed on teeth to straighten teeth and a method for using the same. The apparatus may be constructed of a stiff material and may be customized to fit a particular patient. The stiff material of the appliance

may be snapped into place on some teeth that will not need straightening or that will remain in the mouth in a relative constant position. The teeth that require straightening or guidance into the mouth may be straightened or guided by a semi-stiff or soft customized or prefabricated portion of the appliance.

To fabricate an appliance for a specific patient, the size and shape of the teeth that have not fully erupted into the mouth are predicted. Those teeth already fully erupted in the mouth that require straightening may be properly aligned by the computer or manually on a model for the softer material to be formed around them. In an embodiment of the present invention, the original model of the mouth of a patient is laser scanned. A computer program to estimate the size and shape of the predicted teeth based on the size of the original existing teeth of the patient and the shape based on group standards or means is provided. The actual cast of the original teeth and predicted teeth may be manually made, or a digital three-dimensional image of the same, may be used to construct a model by stereolithography used in tool and die work, from which an appliance, or several graduated appliances, may be manually fabricated. The appliance or several graduated appliances may also be fabricated by stereolithography directly from the digital three-dimensional model.

To this end, in an embodiment of the present invention, a generally U-shaped orthodontic appliance worn on teeth in a mouth of a patient wherein at least one of the teeth require correcting and further wherein the orthodontic appliance has a plurality of layers of material is provided. The orthodontic appliance has a first layer constructed from a first material. The orthodontic appliance has a second layer adjacent to the first layer constructed from a second material wherein the second material is harder than the first material. The orthodontic appliance also has a first socket formed

within the first layer wherein the socket causes movement of a position of at least one of the tooth.

In an embodiment, the orthodontic appliance has a second socket formed within the first layer wherein the second socket maintains the position of at least one of the tooth.

In an embodiment, the orthodontic appliance has walls extending from the first layer.

In an embodiment, the first socket is shaped to correspond to at least one of the teeth.

In an embodiment, the orthodontic appliance has walls extending from the second layer.

In another embodiment of the present invention, a method for correcting a position of a tooth in a mouth of a patient having teeth wherein one of the teeth has a correct position and one of the teeth has an incorrect position is provided. The patient also has a plurality of types of teeth wherein one of the types of the teeth is erupted teeth. The method has the steps of: identifying the position of the tooth; creating an image from the position of the tooth; and predicting a size of an unerupted tooth based on a size of an erupted tooth of the patient.

In an embodiment, the method further has the step of determining the correct position of one of the teeth having the incorrect position based on a model of the tooth wherein the model represents the correct position of the tooth.

In an embodiment, the method further has the step of fabricating an appliance based on the correct position of the tooth.

In an embodiment, the method further has the step of creating a dental appliance having a first portion which contacts a first tooth having the incorrect position wherein the first portion is shaped based on the correct position of the tooth and wherein the dental appliance

has a second portion which contacts a second tooth having a correct position.

In an embodiment, the method further has the step of scanning the teeth of the patient to create the image of the position of the tooth.

In an embodiment, the method further has the step of photographing the teeth of the patient to create the image of the position of the tooth.

In an embodiment, the method further has the step of radio-graphing the teeth of the patient to create the image of the position of the tooth.

In an embodiment, the method further has the step of basing the prediction of the size of the unerupted tooth on race-based anatomical standards for teeth.

In an embodiment, the method further has the step of basing the prediction of the size of the unerupted tooth on mesio-distal standards for teeth.

In an embodiment, the method further has the step of predicting a shape of the unerupted tooth based on standard shapes for teeth.

In another embodiment of the present invention, an orthodontic appliance for teeth of a patient having either a correct position or an incorrect position in the mouth of the patient is provided. The orthodontic appliance has a base sized to fit the teeth of the patient. The orthodontic appliance also has a first slot in the base having a first occlusal surface wherein the first slot is constructed from a first material. The orthodontic appliance also has a second slot in the base having a second occlusal surface wherein the second slot is constructed from a second material and further wherein the first material is harder than the second material and wherein the second slot guides one of the teeth having the incorrect position into the correct position.

In an embodiment, the orthodontic appliance has a socket within the base wherein the socket is shaped in correlation to individual teeth of the user.

In an embodiment, the orthodontic appliance has a socket within the base wherein the socket is sized to receive two or more teeth of the user.

In an embodiment, the first material is adjacent to teeth to be maintained.

In an embodiment, the second material is adjacent to teeth requiring correction.

In an embodiment, the occlusal surface is flat.

In another embodiment of the present invention, a method for adjusting teeth of a patient is provided. The method has the steps of: identifying an orthodontic condition of the teeth of the patient; estimating a position of the teeth wherein the position is a correct position in the mouth of the patient and further wherein the correct position provides a proper occlusion of the teeth of the patient; and creating a dental appliance having a socket to rotate the teeth of the patient into the correct position wherein the socket is based on a predicted size of a tooth which has not erupted.

In an embodiment, the method further has the step of creating a model of the teeth of the patient.

In an embodiment, the method further has the step of providing a second socket in the dental appliance wherein the second socket maintains a position of a tooth having the correct position.

In an embodiment, the method further has the step of obtaining an image of the teeth of the patient.

In an embodiment, the method further has the step of calculating a distance between the position of the tooth and the correct position for the tooth.

In an embodiment, the method further has the step of creating a retainer shaped to receive the teeth of the patient when the teeth are in the correct position.

In another embodiment of the present invention, a system for adjusting teeth of a patient is provided. The system has an image capturing device which obtains an image of the teeth of the patient wherein at least one of

the teeth has an incorrect position. The system also has a central processing unit which receives the image of the teeth from the image capturing device wherein the central processing unit estimates a correct position of the teeth and further wherein the central processing unit determines a shape of a first dental appliance worn adjacent to the teeth based on the correct position of the tooth.

In an embodiment, the central processing unit determines a shape of a second dental appliance worn adjacent to the teeth after the first dental appliance is worn wherein the second dental appliance maintains the tooth in the correct position.

In another embodiment of the present invention, a generally U-shaped orthodontic appliance for teeth of a patient having either a correct position or an incorrect position in the mouth of the patient wherein a predicted position is a correction of the incorrect position in the mouth is provided. The orthodontic appliance has a base sized to fit the teeth of the patient wherein the base is constructed from a single material. The orthodontic appliance also has a first socket in the base to receive one of the teeth in the incorrect position and further wherein the first socket causes movement of one of the teeth in the incorrect position to the predicted position.

In an embodiment, the orthodontic appliance has a second socket in the base to receive one of the teeth in the correct position.

In an embodiment, the first socket is shaped to correspond to a plurality of the teeth in the incorrect position.

It is, therefore, an advantage of the present invention to provide an apparatus, a system and a method for automatic straightening of teeth with fewer appliances, fewer or no adjustments and fewer or no appointments.

Another advantage of the present invention is to provide an apparatus, a system and a method for straightening of teeth that is simple to use.

Yet another advantage of the present invention is to provide an apparatus, a system and a method for straightening of teeth that requires little or no adjustments by a dentist or orthodontist.

Further, an advantage of the present invention is to provide an apparatus, a system and a method for straightening of teeth wherein the apparatus may be constructed of stiff material, soft resilient material, or a combination of both stiff and soft resilient material.

Another advantage of the present invention is to provide an apparatus, a system and a method for straightening teeth that may be less costly than conventional methods.

A still further advantage of the present invention is to provide an apparatus, a system and a method for straightening of teeth wherein teeth of a patient may be duplicated and straightened by a computer or manually.

Yet another advantage of the present invention is to provide an apparatus, a system and a method for straightening of teeth wherein the apparatus may be fabricated by computer using stereolithography or manually.

Another advantage of the present invention is to provide an apparatus, a system and a method for straightening teeth, guiding erupting teeth and guiding the eruption of yet unerupted teeth, wherein the prediction of the sizes and shapes of certain teeth to be adjusted or guided in eruption may be based on the sizes and shapes of other adult teeth already fully erupted in the mouth of the patient or from group standards

Further, an advantage of the present invention is to provide an apparatus, a system and a method for

straightening of teeth wherein the apparatus may require few or no adjustments or appointments.

Still further, another advantage of the present invention may be to provide an apparatus, a system and a method for straightening of teeth providing a computer generated three-dimensional digital model or image of the dentition.

Additional features and advantages of the present invention are described in, and will be apparent from, the detailed description of the presently preferred embodiments and from the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates a black box diagram of a system in an embodiment of the present invention.

Fig. 2 illustrates a flowchart of a method in an embodiment of the system of the present invention.

Fig. 3 illustrates a top view of a mouth used to form a model in an embodiment of the present invention.

Fig. 4 illustrates a perspective view of an appliance in an embodiment of the present invention.

Fig. 5A illustrates a cross sectional view taken along line V-V of Fig. 4 of an embodiment of the present invention having a stiffer section where the teeth do not require straightening, and a softer section in an area where the teeth require straightening which is in direct contact with the teeth.

Fig. 5B illustrates a cross sectional view of the appliance in another embodiment of the present invention.

Fig. 5C illustrates a cross sectional view of the appliance in another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

The present invention generally relates to an apparatus, a system and a method for automatic tooth straightening. More specifically, the present invention provides an appliance that may be placed on teeth to straighten teeth and provides a system and method for

using the same. The apparatus may be customized to fit a particular patient wherein a portion of the appliance may be attached to erupted teeth that are substantially straight. (Erupted teeth are teeth that have substantially emerged through the gum of the mouth into full biting relation with the opposite arch or jaw.) The appliance may remain in the mouth in a relative constant position. The erupted teeth that require straightening may be straightened; and the unerupted teeth or the teeth that are erupting may be guided into the mouth by another portion of the appliance.

To fabricate an apparatus such that the apparatus has a substantially similar anatomy as that of a mouth of a patient, the size and shape of the teeth that have not fully erupted or not yet exited the gums into the mouth may be predicted. The predictions may be accomplished by analyzing sizes of some of the fully erupted adult teeth and shapes from group standards of tooth shapes. From analyzing the sizes of the fully erupted adult teeth, the size of the unerupted or erupting teeth may be calculated as shown in the table below. The shapes of the erupting or non-erupted teeth may be obtained from standards of average anatomic shapes of groups of teeth.

Predicting mesio-distal sizes of adult teeth				
Lateral (lower)	=	Central (lower)	+	0.5 mm
Central (upper)	=	Central (lower)	+	3.25 mm
Lateral (upper)	=	Central (upper)	+	2.0 mm
Lateral (upper)	=	Central (lower)	+	1.25 mm
Incisors (lower 4)	=	Central (lower) x 4	+	1.0 mm
Incisors (upper 4)	=	Incisors (lower 4)	+	8.0 mm
Canine (upper)	=	Lateral (upper)	+	1.25 mm
Canine (upper)	=	Central (upper)	-	1.0 mm
Canine (upper)	=	Canine (lower)	+	1.0 mm

Premolar (upper 1st or 2nd)	=	Central (upper)	-	1.8 mm
Canine (lower)	=	Central (lower)	+	1.5 mm
1st Premolar (lower)	=	Central (lower)	+	1.6 mm
2nd Prmolar (lower)	=	Central (lower)	+	1.9 mm
2nd Permanent Premolar (upper)	=	Dec. 2nd molar (upper)	-	2.25 mm (approx)
2nd Permanent Premolar (lower)	=	Dec. 2nd molar (lower)	-	2.6 mm (approx)
Leeway space lower per side (canine, both premolars)			=	2.5 mm*
Leeway space upper per side (canine, both premolars)			=	1.4 mm*
Low. dec. canine & molars per side (male)			=	23.55 mm
Low. perm. canine & premolars per side			=	21.32 mm
Difference per side = 2.23 mm. MALE				
Low. dec. canine & molars per side (female)			=	23.03 mm
Low. perm. canine & premolars per side			=	20.36 mm
Difference per side = 2.67 mm. FEMALE				
Mean difference lower (male & female per side) = 2.5 mm				
Upp. dec. canine & molars per side (male)			=	23.08 mm
Upp. perm. canine & premolars per side			=	21.78 mm
Difference per side = 130 mm MALE				
Upp.dec.canine & molars per side (female)			=	22.46 mm
Upp.perm.canine & premolars per side			=	21.00 mm
Difference per side = 1.46 mm. FEMALE				
Mean difference upper (male & female per side) = 1.4 mm				

* Average of Male and Female

(See Moorrees, C.F.A.: The Dentition of the Growing Child, Harvard University Press, Cambridge, Mass, 1959.)

The average size and shape of each tooth not fully erupted in the mouth and corresponding to the varius

sizes of other teeth in the mouth may be estimated from a computer program. The other teeth in the mouth may also be estimated manually using charts and various altered models of teeth.

Referring to Fig. 1, a black box diagram of a system for straightening teeth 100 is provided. An original model of the mouth of a patient 102 with crowded incisor teeth and unerupted premolars may be scanned by a laser scanner 104. The scanned information may be used to construct a resin model 108 by stereolithography with straightened incisors and predicted fully-erupted premolars in place with the first permanent molars adjusted forward through the leeway space. Additionally, graduated models may be constructed in order to fabricate appliances to be constructed in a graduated series with gradual changes to allow the teeth to move sequentially from the initial actual or digital model to the final model. A person 109 may manually fabricate an appliance with use of the resin model to form a single appliance 110 for straightening teeth. Additionally, the appliance 110 may be modified and fabricated by stereolithography 111 directly from the computer program 106 that provides a three-dimensional digital image of a model 107. The original model 102 may also be manually made by again resetting the teeth required to be straightened 112, or manually predicting sizes and shapes of teeth to be straightened or that are erupting 114. An appliance or appliances may be manually fabricated from these models 116.

More specifically, referring to Fig. 2, a flowchart of a method for forming a model of a mouth for an apparatus to straighten the teeth of that mouth is provided. First, the original model of a mouth of a patient may be laser-scanned via step 10. Laser-scanning a model of a mouth of a patient is known in the art and is disclosed in U.S. Patent No. 5,975,893 to *Chishli et al.* After laser-scanning the model, the existing

maloccluded or crooked teeth are straightened by computer via step 12 and/or the shape and the size of the predicted teeth may be estimated by a computer via step 14 and may be edited into an initial digital image via step 16. The initial digital image may provide a total digital three-dimensional image and/or cast of the mouth with the original existing straightened teeth together with the projected prefabricated teeth via step 18. Next, either a generated plastic appliance may be computer fabricated by stereolithography via step 24 consisting of predicted preformed teeth and/or actual straightened teeth, or a computer generated resin model via step 20 consisting of similar preformed and/or actual teeth may be made again by stereolithography. This model may then be used to construct thermoplastic, thermosetting plastic or rubber appliances.

The computer-generated stereolithography fabricated resin cast or model of predicted and/or straightened actual teeth may be used to fabricate a single appliance or several graduated appliances may be fabricated manually by pressure or a vacuum with use of graduated resin models via step 22. Alternatively, the appliance or graduated appliances may be fabricated directly by the computer via a stereolithography technique similarly used in tool and die work as shown at step 24 which can bypass the necessity of making a single or graduated resin models. The appliance or appliances may then be issued to the patient via step 26. The computer program may combine a virtual three-dimensional partial digital model with a partial three-dimensional digital prefabricated model of predicted teeth to form a single appliance or multiple appliances or resin model or graduated models from which appliances can be constructed. The computer generated or manually fabricated appliances may be constructed of a total stiff and/or a semi-stiff or soft material or a combination of both, such as, for example,

plastic, rubber, or other material with similar properties.

In an embodiment, an initial model of the teeth of a patient may be made from a manual model of the mouth of a patient. The initial model of the teeth of the patient may also be fabricated by digital photography from various angles of the mouth, digital radiographs or other similar imaging devices. The imaging devices may be combined with an estimate of sizes and/or shapes of various erupting teeth or future eruption of teeth not yet through tissue in various areas of the mouth or including an estimate of sizes and shapes of similar unerupted teeth or slots 408 (as shown in Fig. 4) for more than one tooth. Single or multiple appliances may be fabricated from a stiff plastic or a soft resilient plastic or a combination of both stiff and soft plastic or other material with similar properties.

Referring now to Fig. 3, a mouth 300 of a patient with teeth 302 that may require straightening, sockets 304 for new or missing teeth, and permanent or deciduous substantially straight teeth 306 are generally illustrated. An appliance (not shown) for straightening the teeth may be constructed from, for example, rubber or plastic or other material known by those skilled in the art. The appliance or appliances may correct orthodontic conditions such as overbite, overjet and the like and may be worn in the mouth of a user. The appliance may have many different configurations to correct an orthodontic condition, depending on the age and number of deciduous and adult teeth present in the mouth of the user and for those teeth not yet erupted into the mouth but anticipated to be guided into position.

Fig. 3 further illustrates a first area 308 in the mouth 300 to be cast in a stiff material and a second area 310 in the mouth 300 to be cast in soft resilient material. Fig. 3 further illustrates a prefabricated

area 312 for the unerupted permanent teeth of a patient that will be erupting into the mouth in the near future.

Referring to Fig. 4, an appliance 400 of the present invention is generally illustrated. The appliance 400 may have a first area 402 constructed of a stiff material for attachment to substantially straight erupted teeth. The appliance may further have a second area 404 constructed of a soft resilient material for guiding unerupted teeth into the mouth of adult teeth or teeth that require straightening and a third area 406 for straightening either maloccluded teeth in the mouth or to guide unerupted adult teeth into the mouth into prefabricated sockets or prefabricated slots or grooves for one or more teeth. This area may also be beneficial if made of a soft resilient material. Further, it may be possible to have stiff material extended forward as an outer or interior supporting structure with softer material inside the appliance and contacting the teeth or around the entire outer surface of the appliance. The inner (lingual) walls with softer material contact the teeth surfaces within the same arch, while the outer (buccal, labial and occlusal) surfaces contact the cheeks and teeth surfaces in the same and/or opposite arch.

Referring to Fig. 5A, 5B, and 5C, cross sectional views in different embodiments of the appliance are generally illustrated. The appliance may have a stiffer section where the teeth do not require straightening, and a softer section in an area where the teeth require straightening which is in direct contact with the teeth. The third area 406 (shown in Fig. 4) or any other area of the appliance 400 may have a soft outer layer 501. The soft outer layer 501 may be made of a resilient material. Within the soft outer layer 501 may be a stiff inner layer 502. The stiff inner layer 502 of the appliance 400 may provide support for the appliance 400. Further, within the third area 406 of the appliance 400 may be a preformed socket 503. The preformed socket 503 may be

predicted from the size of other existing adult teeth in the mouth while the shape is predicted from standards of many other similar teeth. Additionally, the socket 503 may be a custom fabricated socket duplicated from the same existing fully erupted adult or deciduous teeth in the mouth.

It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications may be made without departing from the spirit and scope of the present invention and without diminishing its attendant advantages. It is, therefore, intended that such changes and modifications be covered by the appended claims.

I Claim:

1. A generally U-shaped orthodontic appliance worn on teeth in a mouth of a patient wherein at least one of the teeth require correcting and further wherein the orthodontic appliance has a plurality of layers of material, the orthodontic appliance comprising:

a first layer constructed from a first material;

a second layer adjacent to the first layer constructed

from a second material wherein the second material is harder than the first material; and

a first socket formed within the first layer wherein the socket causes movement of a position of at least one of the teeth.

2. The orthodontic appliance of Claim 1 further comprising:

a second socket formed within the first layer wherein the second socket maintains the position of at least one of the teeth.

3. The orthodontic appliance of Claim 1 further comprising:

walls extending from the first layer.

4. The orthodontic appliance of Claim 1 wherein the first socket is shaped to correspond to at least one of the teeth.

5. The orthodontic appliance of Claim 1 further comprising:

walls extending from the second layer.

6. A method for correcting a position of a tooth in a mouth of a patient having teeth wherein one of the teeth has a correct position and one of the teeth has an incorrect position wherein the patient has a plurality of

types of teeth wherein one of the types of the teeth is erupted teeth, the method comprising the steps of:

identifying the position of the tooth;

creating an image from the position of the tooth; and

predicting a size of an unerupted tooth based on a size of an erupted tooth of the patient.

7. The method of Claim 6 further comprising the step of:

determining the correct position of one of the teeth having the incorrect position based on a model of the tooth wherein the model represents the correct position of the tooth.

8. The method of Claim 6 further comprising the step of:

fabricating an appliance based on the correct position of the tooth.

9. The method of Claim 6 further comprising the step of:

creating a dental appliance having a first portion which contacts a first tooth having the incorrect position wherein the first portion is shaped based on the correct position of the tooth and wherein the dental appliance has a second portion which contacts a second tooth having a correct position.

10. The method of Claim 6 further comprising the step of:

scanning the teeth of the patient to create the image of the position of the tooth.

11. The method of Claim 6 further comprising the step of:

photographing the teeth of the patient to create the image of the position of the tooth.

12. The method of Claim 6 further comprising the step of:

radio-graphing the teeth of the patient to create the image of the position of the tooth.

13. The method of Claim 6 further comprising the step of:

basing the prediction of the size of the unerupted tooth on race-based anatomical standards for teeth.

14. The method of Claim 6 further comprising the step of:

basing the prediction of the size of the unerupted tooth on mesio-distal standards for teeth.

15. The method of Claim 6 further comprising the step of:

predicting a shape of the unerupted tooth based on standard shapes for teeth.

16. An orthodontic appliance for teeth of a patient having either a correct position or an incorrect position in the mouth of the patient, the appliance comprising:

a base sized to fit the teeth of the patient;

a first slot in the base having a first occlusal surface wherein the first slot is constructed from a first material; and

a second slot in the base having a second occlusal surface wherein the second slot is constructed from a second material and further wherein the first material is harder than the second material and wherein the second slot guides one of the teeth having the incorrect position into the correct position.

17. The appliance of Claim 16 further comprising:

a socket within the base wherein the socket is shaped in correlation to individual teeth of the user.

18. The appliance of Claim 16 further comprising:

a socket within the base wherein the socket is sized to receive two or more teeth of the user.

19. The appliance of Claim 16 wherein the first material is adjacent to teeth to be maintained.

20. The appliance of Claim 16 wherein the second material is adjacent to teeth requiring correction.

21. The appliance of Claim 16 wherein the occlusal surface is flat.

22. A method for adjusting teeth of a patient, the method comprising the steps of:

identifying an orthodontic condition of the teeth of the patient;

estimating a position of the teeth wherein the position is a correct position in the mouth of the patient and further wherein the correct position provides a proper occlusion of the teeth of the patient; and

creating a dental appliance having a socket to rotate the teeth of the patient into the correct position wherein the socket is based on a predicted size of a tooth which has not erupted.

23. The method of Claim 22 further comprising the step of:

creating a model of the teeth of the patient.

24. The method of Claim 22 further comprising the step of:

providing a second socket in the dental appliance wherein the second socket maintains a position of a tooth having the correct position.

25. The method of Claim 22 further comprising the step

of:

obtaining an image of the teeth of the patient.

26. The method of Claim 22 further comprising the step of:

calculating a distance between the position of the tooth and the correct position for the tooth.

27. The method of Claim 22 further comprising the step of:

creating a retainer shaped to receive the teeth of the patient when the teeth are in the correct position.

28. A system for adjusting teeth of a patient, the system comprising:

an image capturing device which obtains an image of the teeth of the patient wherein at least one of the teeth has an incorrect position; and

a central processing unit which receives the image of the teeth from the image capturing device wherein the central processing unit estimates a correct position of the teeth and further wherein the central processing unit determines a shape of a first dental appliance worn adjacent to the teeth based on the correct position of the tooth.

29. The system of Claim 28 wherein the central processing unit determines a shape of a second dental appliance worn adjacent to the teeth after the first dental appliance is worn wherein the second dental appliance maintains the tooth in the correct position.

30. A generally U-shaped orthodontic appliance for teeth of a patient having either a correct position or an incorrect position in the mouth of the patient wherein a predicted position is a correction of the incorrect

position in the mouth, the orthodontic appliance comprising:

a base sized to fit the teeth of the patient wherein the base is constructed from a single material; and

a first socket in the base to receive one of the teeth in the incorrect position and further wherein the first socket causes movement of one of the teeth in the incorrect position to the predicted position.

31. The orthodontic appliance of Claim 30 further comprising:

a second socket in the base to receive one of the teeth in the correct position.

32. The orthodontic appliance of Claim 30 wherein the first socket is shaped to correspond to a plurality of the teeth in the incorrect position.

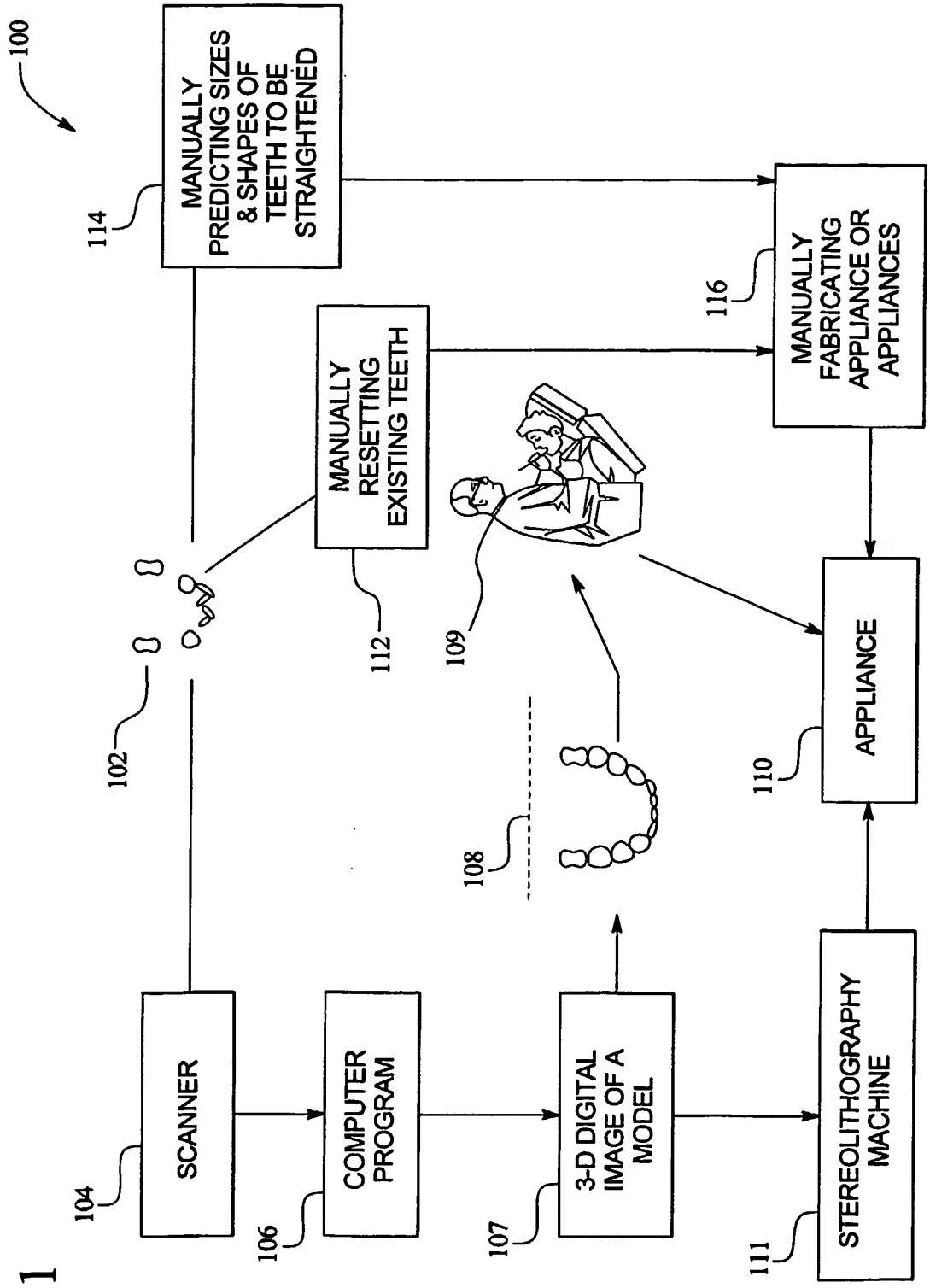

100
MANUALLY PREDICTING SIZES & SHAPES OF TEETH TO BE STRAIGHTENED
114
MANUALLY RESETTING EXISTING TEETH
112
MANUALLY FABRICATING APPLIANCE OR APPLIANCES
116
102
109
108
APPLIANCE
110
SCANNER
104
COMPUTER PROGRAM
106
3-D DIGITAL IMAGE OF A MODEL
107
STEREOLITHOGRAPHY MACHINE
111

FIG. 1

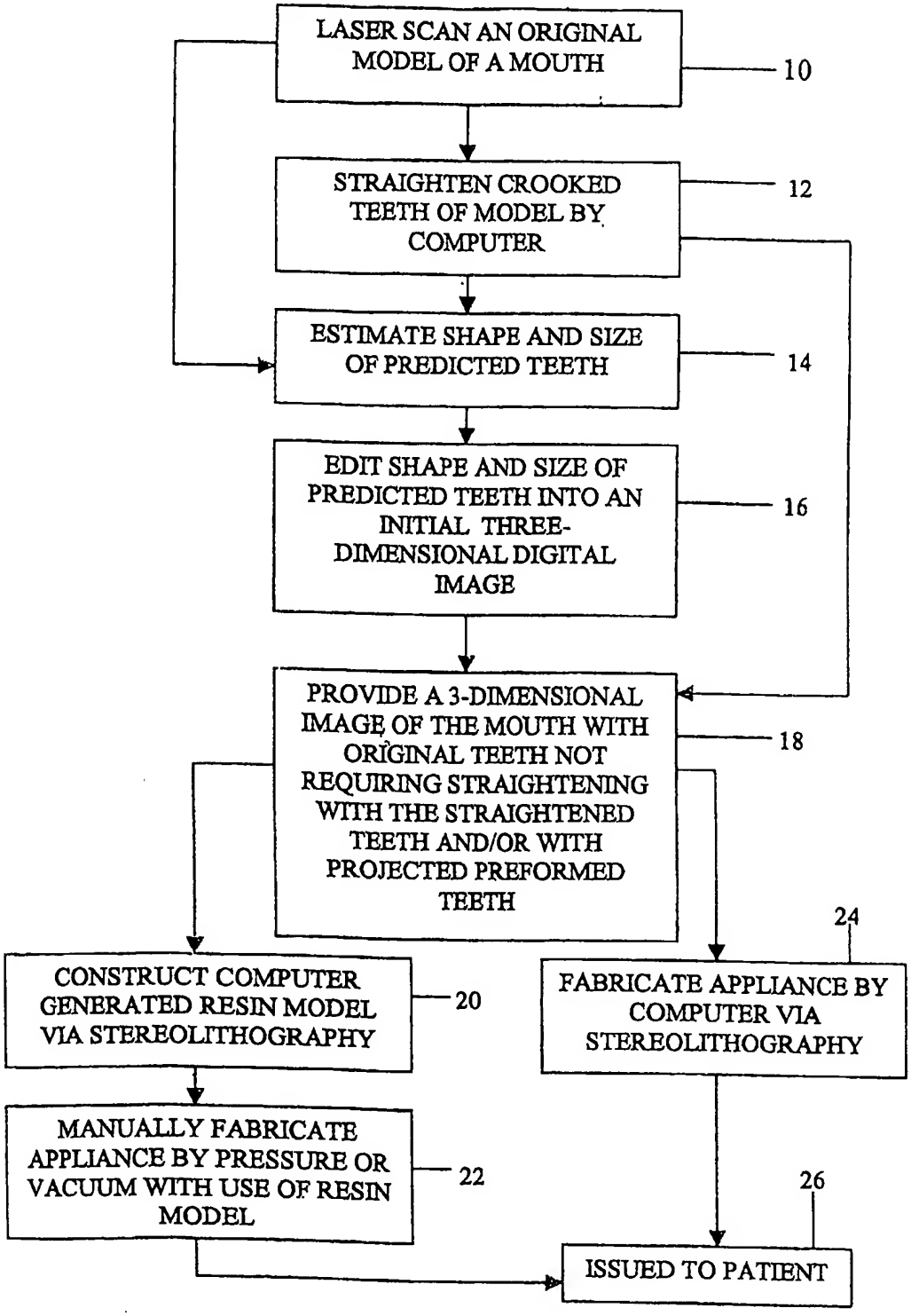

LASER SCAN AN ORIGINAL MODEL OF A MOUTH
10
STRAIGHTEN CROOKED TEETH OF MODEL BY COMPUTER
12
ESTIMATE SHAPE AND SIZE OF PREDICTED TEETH
14
EDIT SHAPE AND SIZE OF PREDICTED TEETH INTO AN INITIAL THREE-DIMENSIONAL DIGITAL IMAGE
16
PROVIDE A 3-DIMENSIONAL IMAGE OF THE MOUTH WITH ORIGINAL TEETH NOT REQUIRING STRAIGHTENING WITH THE STRAIGHTENED TEETH AND/OR WITH PROJECTED PREFORMED TEETH
18
24
CONSTRUCT COMPUTER GENERATED RESIN MODEL VIA STEREOLITHOGRAPHY
20
FABRICATE APPLIANCE BY COMPUTER VIA STEREOLITHOGRAPHY
MANUALLY FABRICATE APPLIANCE BY PRESSURE OR VACUUM WITH USE OF RESIN MODEL
22
26
ISSUED TO PATIENT

FIG. 2

FIG. 3

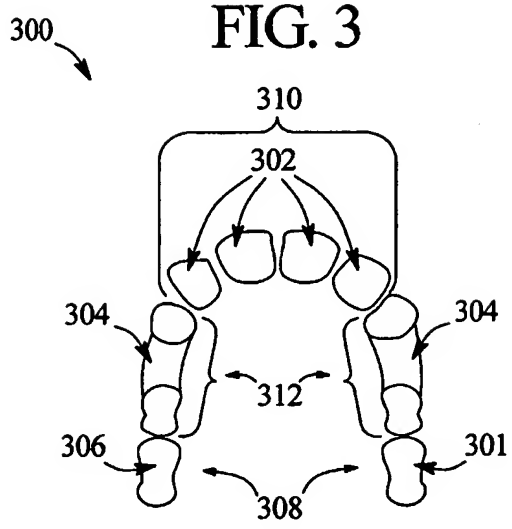


FIG. 4

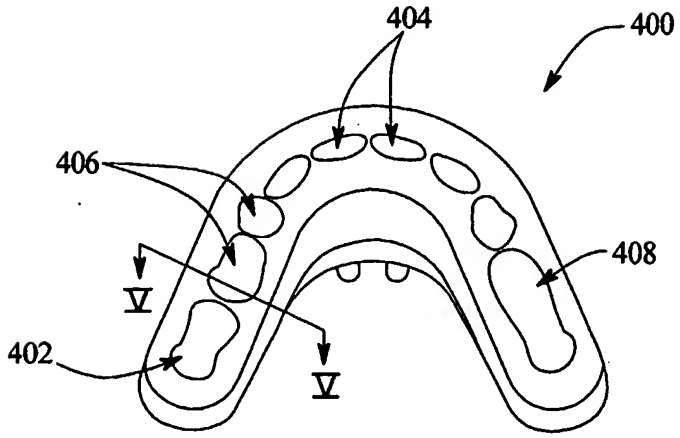


FIG. 5A

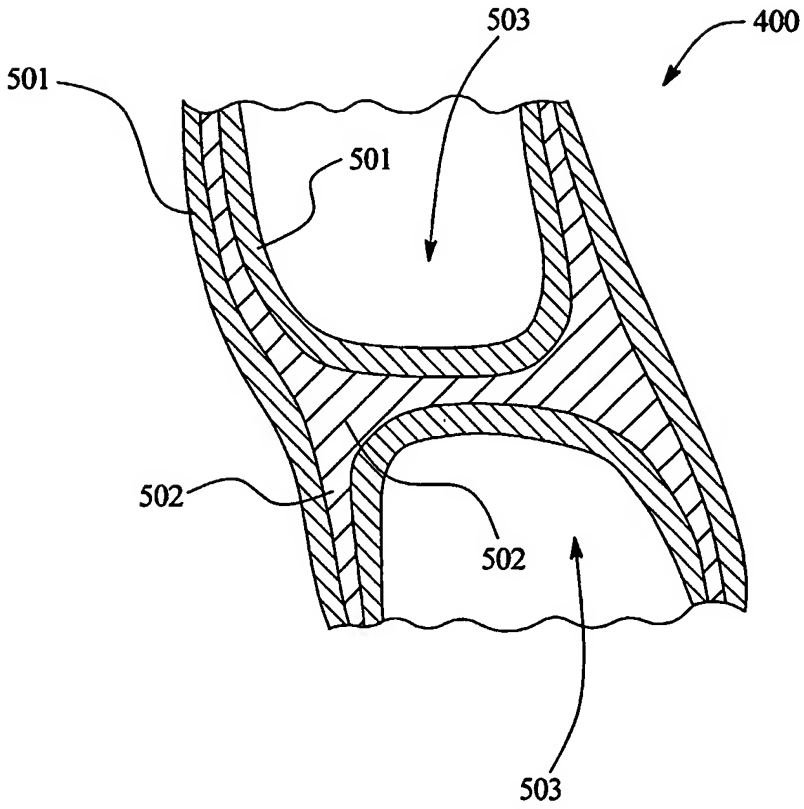


FIG. 5B

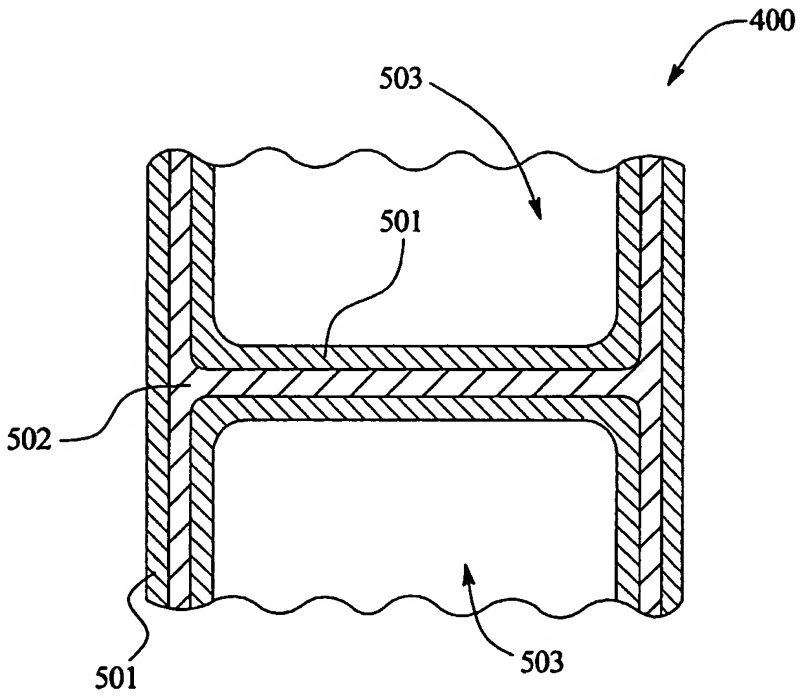
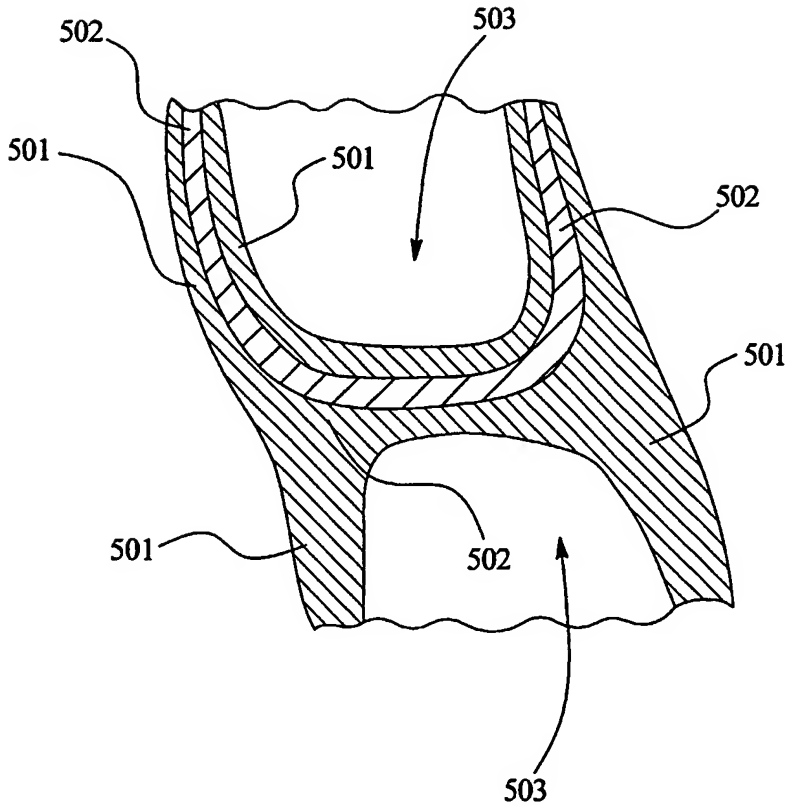


FIG. 5C



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/16725

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : A61C 7/08
US CL : 433/6, 24
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 433/6, 24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
x	US 4,370,129 A (HUGE) 25 January 1983, see entire document.	1-5, 16-21
X	US 2001/0041320 A1 (PHAN et al) 15 November 2001, see entire document.	1-5, 16-21
X	US 5,338,190 A (TREGILLIS) 16 August 1994, see entire document.	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
04 September 2003 (04.09.2003)

Date of mailing of the international search report
07 OCT 2003

Name and mailing address of the ISA/US
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Facsimile No. (703)305-3230

Authorized officer
Todd E. Manahan
Telephone No. 703 308-0858

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/16725

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
Please See Continuation Sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-5, 16-21

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claim(s) 1-5, 16-21, drawn to an orthodontic appliance made of two materials.

Group II, claim(s) 6-15, 22-27, drawn to a method of correcting tooth position.

Group III, claim(s) 28-31, drawn to a system for .adjusting teeth

The inventions listed as Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The special technical feature of the invention of Group I is an orthodontic appliance formed of two material, one being harder.

The special technical feature of the invention of Group II is a method of correcting teeth in which the size of unerrupted teeth are predicted.

The special technical feature of the invention of Group III is a system which utilizes a computer to estimate the correct position of teeth and determine the shape of dental appliance.